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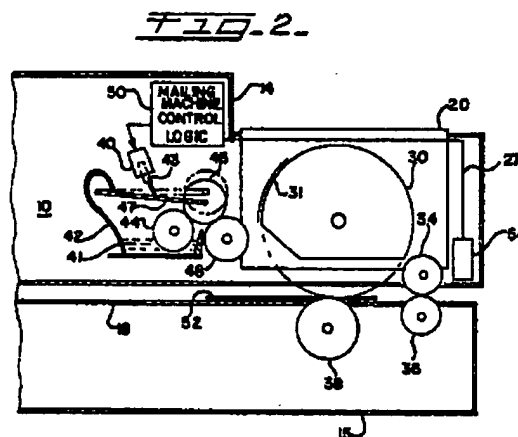
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⑶ Automatic ink level control system.

⑴ Method and apparatus for automatically controlling the inking level of the printed indicia of a value printing machine particularly suitable for postage meters. An ink (41) including a phosphorescent component is used to print the indicia and a sensing unit (54) measures the phosphorescent level of the resulting printed indicia. This measured phosphorescent level is used to control the transfer of ink (41) from an ink reservoir (42) to an inking roller (48) which inks the postage indicia die (31). The mailing machine (10) includes a document feeding bin, an automatic document feeder, a document transport mechanism and a postage meter (20), which when activated, prints postage indicia onto the document - (52) using the method and apparatus for controlling the inking level.



AUTOMATIC INK LEVEL CONTROL SYSTEM

This invention relates generally to the field of value printing devices, and more particularly to an automatic value printing control system for controlling the ink level of the printed value indicia of value printing devices such as mailing machine postage meters.

Mailing machines generally comprising automatic letter feeding apparatus and a postage meter including printing apparatus are in wide use. Postage meters dispense value in the form of printed postage on a document fed to the meter for printing of a metered package impression at the proper location and within specified print density levels. Postage is dispensed in desired increments by printing a postage indicia generally including a selected postage value, the date, and one or more symbols, on the document which may be an envelope, mail label or the like. Postage meters are an example of the general class of printing devices referred to as value printing devices which print indicia representative of value.

Postage meters print postage indicia onto a document by contacting the surface with print characters which are inked typically just prior to the print event. In rotary head postage meters, the print characters are contained on a rotary print head which revolves relative to a stationary inking roller during the print cycle. When the raised print characters encounter the inking roller, they make contact and are thus inked. In flat bed type postage meters, the print characters are contained on a horizontal printing head and the inking roller is moved across the print character just before printing.

In either type of postage meter, the document to be marked is placed into contact with the printing head with enough force to result in printing of the postage indicia. Clearly, if the inking roller does not have enough ink, the postage indicia will be printed with an ink level (i.e. quantity of ink on the paper surface) which is too light and conversely, if the roller has too much ink the ink level of the printed indicia will be too dark.

One prior art method for maintaining minimum ink levels involved a mechanism for limiting the number of cycles of a postage meter in accordance with the capacity of the inking roller, whereupon the roller must be replaced before the printer can be reactivated. Another approach requires the operator to monitor output documents to determine when the printed indicia have become too faint, at which point the operator must take action, such as replacing the inking roller or activating a mechanism for adding ink to the roller. These prior art

approaches are very limiting, inconvenient, and unreliable due to the need for operator intervention.

It is accordingly an object of the invention to provide an improved mailing machine.

It is another object of the invention to provide an improved system for controlling the inking level of a postage meter automatically.

It is yet another object of the invention to provide an improved system for automatically maintaining the inking level of a value printing device using a phosphorescent ink within upper and lower limits by controlling inking in response to the measured phosphorescent level of the printed indicia.

Briefly according to one embodiment in the invention, apparatus is provided for controlling the inking level of a printed indicia in a value printing machine having a controllable inker for providing ink to the indicia die using an ink having a luminescent component. The apparatus comprises means for sensing the ink level of the printed indicia and for generating a control signal in response to the sensed level as well as means for controlling the inker of the value printing machine in response to the control signal.

Brief Description of the Drawings

The invention, together with further objects and advantages thereof, may be understood by reference to the following description taken in conjunction with the accompanying drawings.

Figure 1 is an illustration of a specific embodiment of a mailing machine, including a postage meter in accordance with the invention.

Figure 2 is an illustration of a specific embodiment of a postage meter in accordance with the invention.

Figure 3 is a detailed block diagram of a specific embodiment of the electronic circuitry of the sensor unit as shown in Figure 2 in accordance with the invention.

Figure 4 is a detailed block diagram of a specific embodiment of the electronic control circuitry of the mailing machine as shown in Figure 2 in accordance with the invention.

Figure 4 is a flow diagram of a specific microcomputer routine for the control circuitry of Figure 4 in accordance with the invention.

Detailed Description of the Preferred Embodiment

Figure 1 is an illustration of a specific embodiment of a mailing machine 10 having a postage meter 20 in accordance with the invention. The mailing machine 10 includes a document feeder bin 12 for holding documents for an automatic feeder 13 which feeds to a conventional belt and roller document transport mechanism (not shown) contained within an upper housing 14 and a lower housing 15. The document feeder 13 and transport mechanism are driven in the conventional manner by an electric motor (not shown) also contained within the housing 14. An adjustment knob 16 permits adjustment of the feeder 13 to provide for a range of envelope thicknesses. The transport mechanism includes a transport belt (not shown) to move each document along a document deck 18 to the postage meter 20 which, when activated, prints a postage indicia on the document.

The mailing machine 10 may also include means for sealing the document envelope. A control panel 22, including control keys and a visual display, provides for operator control of the mailing machine 10 functions. A machine operate lever 24 permits the meter to be disabled so that the mailing machine 10 only seals envelopes without printing a postage indicia, and further permits the meter to be detached from the rest of the mailing machine. Often a document detector (e.g. photo-sensor or microswitch, not shown) is located within the housing to detect the flow of documents through the transport mechanism and trigger activation of a document solenoid (not shown) which activates the postage meter 20.

The postage meter 20 operates in conjunction with the mailing machine 10 with the mailing machine 10 providing a base and a power source for the postage meter 20 as well as providing the ink supply and the means for transporting the documents to the postage meter 20. The ink supplied by the mailing machine is typically a special ink for use in postage meters having a secondary, non-visible but detectable component such as a phosphorescent component (e.g. zinc sulfide) for security purposes. Such value printing machines may also use ink with other non-visible, detectable, secondary components in the illustrated embodiment such as other luminescent materials (i.e. a material which radiates visible light when stimulated) including phosphorescent (long persistence), fluorescent (short persistence) materials, or cathodoluminescent materials (stimulated by an electron beam) or magnetic materials (e.g. Iron Oxide).

Referring now to Figure 2, there is shown an illustration of the postage meter 20 and associated components of the mailing machine 10 in accordance with the invention. The postage meter 20 comprises a rotating print drum 30 having a printing indicia die 31 for printing the postage indicia

including a selected postage value, the date, and one or more postage symbols. In addition, a document ejection drum 34 is provided which acts in conjunction with the a second document ejection drum 36, mounted in the mailing machine as shown, to eject a document after printing.

In operation, the mailing machine 10 transports the document 52 to the mailing machine 20 along the document deck 18 where it is positioned over a document carriage drum 38, as shown. The postage meter is then activated such that the print drum 30 rotates (counter-clockwise in the illustrated embodiment) bringing the printing die 31 in contact with the document 52 thus printing the indicia and moving the document 52 forward until it is captured by the ejection drum 34, 36. The document is then ejected out of the machine under a secondary component sensor unit 54. During the rotation of the print drum 30 the printing die 31 contacts an inking roller 43 which rolls over the printing die 31 thereby inking the die on each rotation. Clearly, when the inking roller 43 runs low on ink the printing die 31 will not be adequately inked and the postage indicia will be printed to lightly.

Ink can be added to the inking roller 48 from an ink reservoir 42 by the action of an ink solenoid 40, an intermediate ink transfer roller 46, and an ink reservoir roller 44, configured as shown. When the intermediate roller 46 is brought in contact with the inking roller 48 and reservoir roller 44 by extending the solenoid armature 43, ink 41 (having a phosphorescent component in a standard mailing machine) from the reservoir 42, is transferred to the inking roller 48. This ink transfer is the result of the rotational motion of the rollers caused by contact with the rotating print drum 30. This ink roller mechanism permits automatic control of the ink level (i.e. the quantity of ink printed onto the page surface).

As shown in Figure 2, the secondary component sensor unit 54 (in the illustrated embodiment sensor unit 54 is a phosphorescent sensing unit) is mounted at the point of exit of the documents from the postage meter for sensing the ink level of the printed indicia and generating an output control signal in response to the sensed ink level. This sensor 54, in the illustrated embodiment, detects the ink level of the printed indicia by measuring the magnitude of the non-visible, detectable secondary component of the indicia. In the illustrated embodiment this secondary component is a luminescent material, typically a phosphorescent material as is standard in mailing machine inks. This sensed phosphorescent level is coupled to the mailing machine control circuitry 50 via a conductor 27, as shown. The mailing machine control circuitry 50 controls the functions of the mailing machine as well as the automatic inking system. A separate

control circuit may also be used to control the automatic inking system using the signals from sensor unit 54.

The mailing machine control circuitry 50 generates a control signal to extend the solenoid armature 43 (i.e. activate the solenoid) if the sensed level from the sensor 54 is less than a predetermined minimum. The transfer roller 46 will then remain in contact with rollers 44, 48 due to the extended solenoid armature 43, thereby continually increasing the ink level until the sensed level from the sensor 54 equals or exceeds a predetermined maximum. At that time, the control circuit 50 will generate a signal to retract (i.e. deactivate) the solenoid armature 43 pulling the transfer roller 46 out of contact with the rollers 44 and 48, thereby terminating the ink transfer process.

Figure 3 is a detailed block diagram of a specific embodiment of the electronic circuitry of the secondary component sensor unit 54 (see Figure 2) in accordance with the invention. The sensor unit 54 comprises an excitation source 56 for stimulating emissions from the printed indicia by illuminating the surface of the document 52, as shown. The excitation source 56, for example, may be an electron source in the event the secondary ink component is a cathodoluminescent or a light source in the event that a photoluminescent is utilized. Other sources may be used, or none at all, depending on the secondary component used in the ink. In the illustrated embodiment the excitation source 56 is an ultraviolet source coupled to a power source (not shown). The ultraviolet light source is used in sensor unit 54 in conjunction with inks having certain phosphorescent or fluorescent secondary components, as in postage meter ink.

The sensor unit 54 also comprises a detector 58 (e.g. a photodetector such as a photo diode) which detects the magnitude of the emitted light from the secondary component of the printed indicia ink. The photo detector 58, as shown, generates a signal representative of the magnitude of the light emitted which is coupled via conductor 27 to the machine control logic 50 (see Figure 2). An optional filter 60 can be located in front of the photo detector 58 to filter out all light except the wavelengths which are emitted by the secondary component due to the excitation source 56, thereby reducing interference from extraneous light sources. In the event a non-luminescent secondary component is used, the excitation source 56 may be eliminated and only a detector is required (e.g. if a magnetic secondary ink component is utilized).

Referring now to Figure 4, there is shown a detailed block diagram illustrating a specific embodiment of the electronic control circuitry 50 for the mailing machine 10. A microcomputer 202 (e.g., an Intel 8031) provides the central processing

capability for the mailing machine 10 with its internal oscillator regulated by a crystal and capacitor network 201 and power-up reset provided by a capacitor 203. Such microcomputer controlled mailing machines are well known in the art.

An electronically programmed read only memory (EPROM) 204 provides field programmable program memory for the microcomputer 202. This programmable device 204 is addressed by the microcomputer 202 via a bus 208 coupled to bus interface buffers 210, as shown. Additional address and control signals are coupled from the microcomputer 202 to the EPROM 204 via the bus 208 and addressed data from the EPROM 204 is coupled to a data bus 214, as shown. The bus interface buffer 210 additionally provides buffering for passing data between bus 208 and the data bus 214, as shown.

Sensor signals which utilize an interrupt input to the microcomputer 202 (e.g. document sensor 222, as shown) are coupled through the interrupt buffer 224 to selected interrupt inputs 223. Any additional inputs required for mailing machine operation (e.g. postage meter disconnect) are coupled through the input buffer 226 to the data bus 214 and through to the microcomputer 202 via the bus interface 210.

Also coupled to the input buffer 226 is the secondary component level signal (e.g. phosphorescent level signal in the illustrated embodiment), which is coupled from the secondary component sensor unit 54 (shown in Figure 2) to an Analog to Digital (A/D) converter 229 via the conductor 27, as shown. The A/D converter 229 converts the analog signal from the sensor unit 54 to a digital signal which is coupled via the conductors 228 through the input buffer 226 to the data bus 214. These signals are then coupled via the bus interface 210 to the microcomputer which analyses the digitized signal and produces a control signal to activate or deactivate the ink solenoid 40 at the appropriate time.

Control signals, such as the signal controlling the ink solenoid 40 and the document solenoid 232, are coupled from the microcomputer 202 through the data base 214 to the output power buffers 230, as shown. The output power buffers, in response to the control signals from the microcomputer, drive the control solenoids and in addition, control the motor (not shown) which drives the document feeder and transport mechanism.

The microcomputer 202 also communicates with a control panel 22 via an interface buffer 234 which couples, as shown, to the data bus 214. The data coupled through the buffer 234 permits operator control of the mailing machine 10.

Figure 5 is an illustration of a flow diagram of a specific routine for the microcomputer 202 to con-

control the ink solenoid 40 according to the invention. The routine of Figure 5 is entered at block 300 after the printing of each indicia, and program control immediately proceeds to block 310 where initialization occurs setting up any required initial values, such as minimum and maximum secondary component values. The current secondary component value (SC) is then read from the A/D converter 229 (see Figure 4) as indicated at 320 and the current value is compared to the predetermined minimum as illustrated at 330. If the result of the comparison at 330 is positive the microprocessor 202 activates the ink solenoid 40 as indicated at 350 and then the ink solenoid control routine is exited as indicated at 360. However, if the result of the comparison at 330 is negative, the current secondary component value is compared to the maximum predetermined value as indicated at 370. If the result at 370 is negative, the ink solenoid control routine is exited as illustrated at 390, and if the result at block 370 is positive, the ink solenoid 40 is deactivated as illustrated at block 380. After the ink solenoid 40 has been deactivated the ink solenoid control routine is exited as shown at block 390.

A specific embodiment of the novel method and apparatus for controlling the inking level of a printed indicia in a value printing machine has been described for the purpose of illustrating the manner in which the invention may be made and used. It should be understood that implementation of other variations and modifications of the invention and its various aspects will be apparent to those skilled in the art, and that the invention is not limited by the specific embodiment described. It is therefore contemplated to cover by the present patent any and all modification, variations, or equivalents of the inventions that fall within the true spirit and scope of the basic underlying principals disclosed and claimed herein.

Claims

1. Apparatus for controlling the inking level of a printing indicia printed by the indicia die of a value printing machine, comprising:

controllable inking means for providing ink to the indicia die;

means for sensing the inking level of the printed indicia and generating a control signal in response thereto; and

means (50) for controlling the controllable inking means in response to the control signal.

2. The apparatus of claim 1, wherein the controllable inking means utilizes an ink (41) having a secondary non-visible component, and wherein the means for sensing (54) comprises means for sensing the secondary non-visible component level of the printed indicia and for generating the control signals in response to said secondary non-visible component level.

3. The apparatus of claim 2, wherein the secondary non-visible component is a phosphorescent component.

4. The apparatus of claim 2, wherein the secondary component is a luminescent component and wherein the means for sensing (54) further comprises means (58) for stimulating the luminescent component to emit visible light and means (58) for sensing the magnitude of the visible light emitted by the secondary, non-visible component.

5. The apparatus of claim 2, wherein the controllable inking means comprises ink reservoir means (42) for holding a quantity of ink (41) having said secondary non-visible components, and transfer means (44, 46, 48) for transferring ink from the ink reservoir means to the indicia die (31) in response to activation by the means for controlling (50).

6. The apparatus of claim 5, wherein the transfer means (44, 46, 48) comprises a rotatable reservoir roller (44) in contact with the ink (41) of the ink reservoir means (44, 46, 48), a rotatable transfer roller (48) for transferring ink (41) from its surface to the indicia die (31) by rotating over the surface of the indicia die (31) prior to printing and an intermediate rotatable roller (46) for simultaneously contacting both the reservoir roller (44) and the transfer roller (48) in response to activation by the means (50) for controlling thereby transporting ink (41) from the ink reservoir roller (44) to the transfer roller (48).

7. The apparatus of claim 6, wherein the means (50) for controlling comprises means for generating an activation signal responsive to the control signal and means for activating the intermediate roller (46) in response to the activation signal.

8. The apparatus of claim 5, wherein the means (50) for controlling activates the transfer means (44, 46, 48) in response to the secondary non-visible component level falling below a predetermined minimum level and deactivates the transfer means (44, 46, 48) in response to the secondary component level rising above a predetermined maximum level.

9. A method of controlling the quantity of ink (41) printed on the surface of an article by the indicia die (31) of a value printing device having a controllable inker using an ink (41) having a secondary non-visible component, the method compris-

ing the steps of sensing the magnitude of the secondary non-visible component of the ink (41) printed on the surface of the printed article; and

controlling the inker in response to the sensed magnitude of the secondary non-visible component.

10. The method of claim 9, wherein the secondary, non-visible component is a luminescent component.

11. The method of claim 9, wherein the step of sensing comprises the steps of stimulating the secondary non-visible component of the ink of the printed surface to radiate visible light and sensing the visible light radiated by the secondary, non-visible component.

12. The method of claim 2, wherein the step of controlling the inker comprises the steps of generating a control signal responsive to the sensed level of the secondary non-visible component, and transferring ink (41) from an ink reservoir (42) to the indicia die (31) in response to the control signal.

13. The method of claim 9, wherein the inker comprises an ink reservoir (42), an inking roller (48) for inking the indicia die (31) and an ink transfer means (44, 48) for transferring ink (41) to the inking roller (48) when activated, the method further comprising the steps of generating an activation signal in response to the sensed secondary, non-visible component level falling below a predetermined minimum level, generating a deactivation signal in response to the sensed secondary, non-visible component level rising above a predetermined maximum, activating the ink transfer means (44, 48) in response to the activation signal and deactivating the ink transfer means (44, 48) in response to the deactivation signal.

14. A mailing machine (10), including a postage meter (20) having a printing mechanism for printing a postage indicia using an ink (41) having a luminescent component, comprising:

document holding means (12) for holding a plurality of documents (52) for processing by the mailing machine (10);

document feeder means (13) for feeding each document (52) from the document holding means into the mailing machine;

document transport means for transporting each document (52) from the document feeder means to the postage meter (20);

means for activating the printing mechanism of the postage meter to print a postage indicia on the document (52);

sensor means (54) for sensing the luminescent level of the printed postage indicia subsequent to printing of the postage indicia and for generating a control signal in response thereto, and

control means (50) for controlling the supply of ink to the postage indicia printing mechanism in response to the control signal.

15. The mailing machine of claim 14, wherein the sensor means comprises means (56) for stimulating the luminescent component of the ink (41) in the printed postage indicia to emit visible light, and means (58) for sensing the magnitude of the visible light emitted.

16. The mailing machine (10) of claim 15, wherein the luminescent component is a phosphorescent component.

17. The mailing machine (10) of claim 16, wherein the means (56) for stimulating the phosphorescent component is an ultra-violet light source.

18. The mailing machine (10) of claim 14, wherein the control means comprises ink reservoir means (42) for holding a supply of ink (41) having a luminescent component and transfer means (44, 48) for transferring ink (41) from the ink reservoir means (42) to the postage indicia printing mechanism in response to the control signal.

19. The mailing machine (10) of claim 18, wherein the transfer means (44, 48) comprises a rotatable reservoir roller (44) in contact with the ink (41) of the ink reservoir means (42), a rotatable transfer roller (48) for transferring ink (41) from its surface to the postage indicia printing mechanism and an intermediate rotatable roller (46) for simultaneously contacting both the reservoir roller (44) and the transfer roller (48) in response to the control signal thereby transporting ink (41) from the ink reservoir roller (44) to the transfer roller (48).

20. The mailing machine (10) of claim 19, wherein the control means (50) further comprises activation means for generating an activation signal responsive to the control signal and means for activating the intermediate roller (46) in response to the activation signal.

21. The mailing machine (10) of claim 20, wherein the activation means generates an activation signal in response to the luminescent level falling below a predetermined minimum level and disables the activation signal in response to the secondary component level rising above a predetermined maximum level.

22. The mailing machine (10) of claim 15, wherein the luminescent component is a fluorescent component.

23. The mailing machine (10) of claim 15, wherein the luminescent component is a cathodoluminescent component.

24. The mailing machine (10) of claim 15, wherein the means (58) for sensing the magnitude of the visible light comprises a filter means (60) for filtering out light frequencies other than those emitted by the luminescent component.

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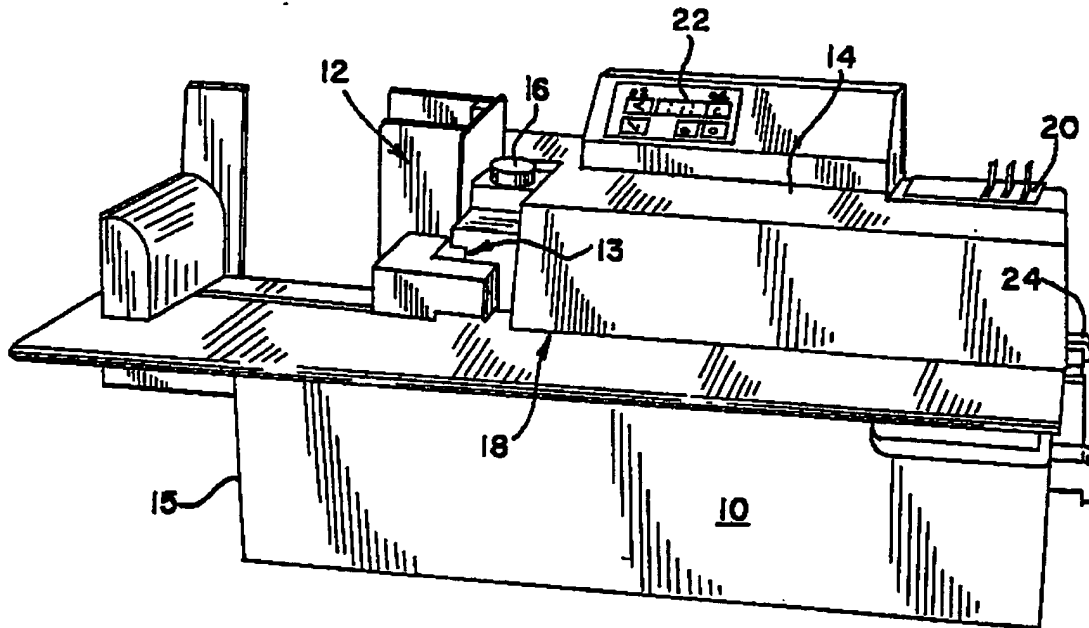
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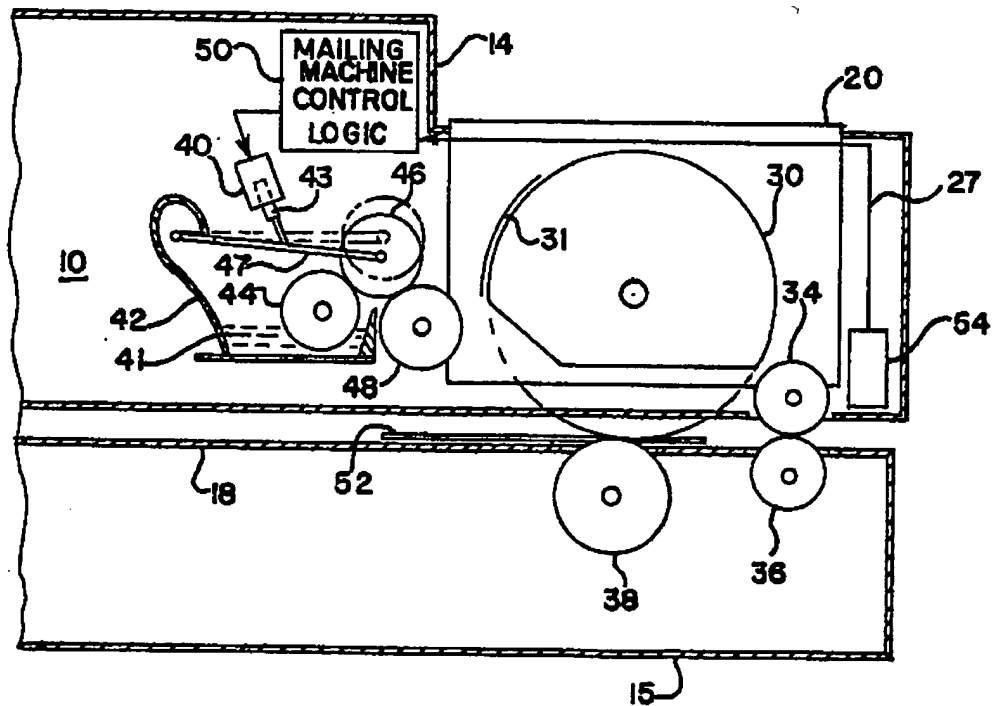
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Fig-1



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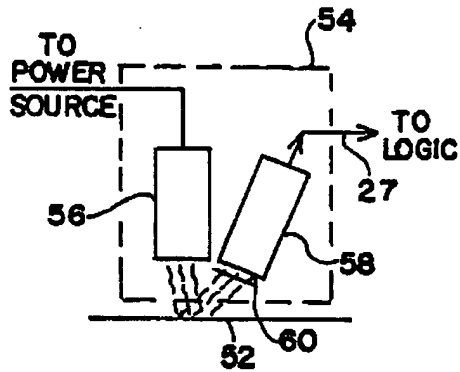


The diagram illustrates the relationship between the number of nodes (n) and the number of edges (m) for a graph. It is divided into three sections:

- Left section:** A single node is shown with $n=1$ and $m=0$.
- Middle section:** A single node is shown with one edge, labeled $n=1, m=1$.
- Right section:** A single node is shown with two edges, labeled $n=1, m=2$.

The diagram is labeled with n and m at the bottom.

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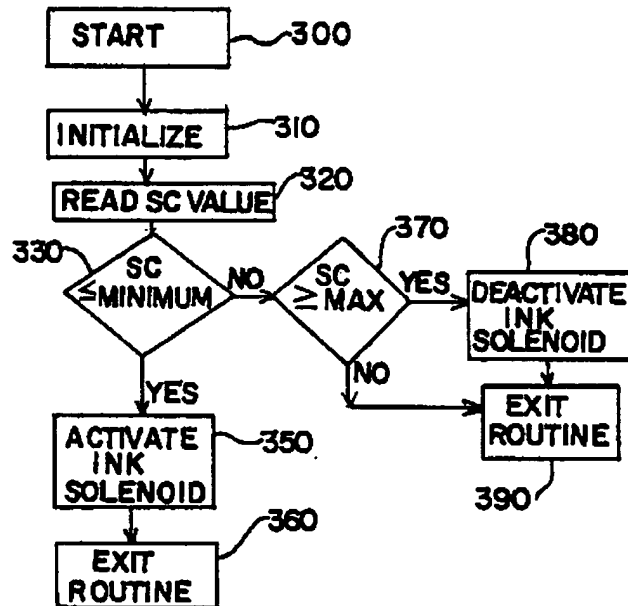


Fig. 4.

